CERTIFICATE

This is to certify that this dissertation titled **“ Surgical Management Of Chronic Subdural Hematoma: Comparison between single burrhole closed system drain technique and conventional double burrhole open drain technique”** is the bonafide original work of **Dr. K. PRABHURAMAN** in partial fulfillment of the requirements for Branch – II, M.Ch., Neurosurgery examination of the **THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY** to be held in August 2011. The period of postgraduate study and training was from August 2008 to July 2011.

DECLARATION

I solemly declare that this dissertation **" Surgical Management Of Chronic Subdural Hematoma: Comparison between single burrhole closed system drain technique and conventional double burrhole open drain technique"** was prepared by me in the Institute of Neurology, Madras Medical College and Government General Hospital, Chennai between 2008 and 2011.

This dissertation is submitted to The Tamilnadu Dr.M.G.R. Medical University, Chennai in partial fulfillment of the University requirements for the award of degree of M.Ch. Neurosurgery.

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Introduction

Aim of study

Review of literature

Materials and methods

Results

Discussion

Conclusion

References

Appendix

THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY

SURGICAL MANAGEMENT OF CHRONIC SUBDURAL HEMATOMAS: Comparison between single burrhole closed system technique and conventional double burrhole technique.

Dissertation submitted in partial fulfillment of the requirements for the degree of

M.Ch. Branch – II

NEUROSURGERY (Three years Course)

Examination in AUGUST 2011

INSTITUTE OF NEUROLOGY

MADRAS MEDICAL COLLEGE

CHENNAI - 3

Introduction

Chronic Subdural Hematoma (chronic SDH) is one of the most common clinical entities faced by neurosurgeons in their day to day practice. The incidence of chronic SDH is 1-2 cases per 100,000 population per year. It is more common in old age where brain atrophy with increased space between the brain and skull facilitates the formation of Chronic SDH.

There are many surgical techniques for chronic SDH; one or two burrhole craniostomy, twist drill craniostomy, craniotomy and excision of subdural membranes, reservoir shunting for continuous irrigation and drainage, percutaneous needle trephination etc.

Burrhole craniostomy is accepted as the most common treatment especially in the older patients with pulmonary and cardiac complications and the aim will be minimal intervention with minimal anaesthesia.

In this study, an attempt has been made to compare single burrhole with closed drain method and the conventional double burrhole with open drain method in the treatment of chronic SDH.

AIM OF THE STUDY

To compare the single burrhole closed drain technique with the routinely used double burrhole open drain technique in the surgical management of chronic SDHs.

REVIEW OF LITERATURE

Hemorrhage occurring in the dura-arachnoid interphase produces subdural hematomas. Chronic SDHs are usually more than 3 weeks old. The annual incidence of chronic SDH is about 1-2 per 100000 population. Most patients are 50 years of age or older. Between one quarter and one half have no history of head injury and in those with a history of trauma, the injury was often a mild one. A significant proportion of patients are predisposed to SDH by chronic alcoholism, epilepsy or coagulopathies.[20]

ETIOLOGY:

- Head trauma, mild, especially in old individuals with brain atrophy
- Progression of an acute SDH into chronic SDH
- Spontaneous or idiopathic especially in patients on anticoagulants and patients with bleeding diathesis such as hemophilia.

Risk factors for Chronic SDH include alcoholism, epilepsy, coagulopathy, anticoagulant therapy, and cardiovascular diseases.

Pathophysiology:

Chronic SDHs are encountered in 10% of elderly patients with head injuries. In patients older than 50 years, the mass of the brain is reduced by approximately 200g, which results in an increased dead space of upto 11%.[24] Small amounts of hemorrhage into the subdural space or larger hematomas in patients with brain atrophy may fail to produce any symptoms. Within 1 week, the hematoma is covered by another membrane beneath the dura, and by three weeks an inner membrane forms between the hematoma and the arachnoid surface over the brain, thus completely enclosing the hematoma. During this period the hematoma liquefies and becomes more hypodense on the CT.

Two theories have been postulated for the enlargement of the hematoma:

1. Osmotic gradient theory
2. Recurrent hemorrhage from hematoma capsule associated with hyperfibrinolysis theory.

Osmotic gradient theory:

It has been postulated that a chronic SDH enlarges because the capsule acts as an osmotic membrane , with cerebrospinal fluid diffusing into the hematoma and increasing its volume. Zollinger and Gross[30] suggested that the flow across the membrane occurs as a result of an increase in osmotic pressure from breakdown of hemoglobin molecules. This theory has now been discredited because it has been shown that the osmolality of the hematoma does not change with time. Moreover the ratios of albumin to gamma globulin and of albumin to total protein are higher in the hematoma than in the serum.

Recurrent hemorrhage from hematoma capsule associated with hyperfibrinolysis theory :

The subdural space is a closed space. Its outer wall is duramater that consists of a dense fibrous membrane with poor vascularisation, and its inner wall is the vascularised arachnoid with no capillary bed. The inner layer of the dura mater has a very high reaction potential for cellular organization and contains a very fine network of interconnected capillaries. When an acute hematoma is limited to subdural space without arachnoid tear, the hematoma dissects within the layer of dural border cells. All surfaces of all serous cavities normally absorb any foreign material when contact is made. Accumulation of blood, fibrin, and Fibrin Degradation Products(FDP) within the subdural space may lead to either cellular organization with resorption of the subdural collection or to the development of a gradually enlarging SDH.[28]

Formation of Neomembrane :

Inner and outer membranes are formed around the hematoma during the second week with the hematoma being traversed by collagen and elastic fibers and sprouting capillaries (sinusoidal vessels). These sinusoidal vessels are actually giant capillaries with a lumen of 80µm or more in diameter. These macrocapillaries are fragile and have a tendency to undergo repetitive multifocal bleeding. The hematoma cavity is exposed to transmitted pulsations from the brain and changes in head position which are accentuated by the liquid volume of the SDH leading to rupture of the fragile vessels.[19]

Hyperfibrinolysis :

The fibrin used up for the formation of the neomembrane is degraded to fibrin degradation products (FDP), which is markedly increased in chronic SDH, so the subdural hematoma fluid does not usually clot. FDPs are also well known to have anticoagulation properties and produce a vasodilator effect.[13]

Excessive activation of hematomic coagulation :

The marked reduction in levels of factor VII as well as factors II, V, and X is due to excessive activation of both the extrinsic clotting system and the common final pathway leading to consumption coagulopathy within the hematoma.

Exudation vs transudation within the hematoma :

Virchow[25,26] was the first to describe chronic SDH as a dural inflammatory disease called “pachymeningitis hemorrhagica interna”. Immunohistochemical studies demonstrated that the cytokine vascular endothelial growth factor, which is responsible for the neovascularisation and vascular hyperpermeability, appears in the outer membrane. Substances such as bradykinin and IL 6 are also seen.

Watanabe[26] showed that the growth content of experimental chronic SDH was proportional to the thickness of the macrocapillaries and to the degree of leakage. Glover and Labadie[5] found that the enlargement of an experimental chronic SDH was strongly correlated with increased capillary permeability, and dexamethazone inhibited its growth. Bender[4] also reported using corticosteroids treatment in a series of patients with Chronic SDH.

Transudation **:** at the beginning of inflammation, blood vessels dilate and become leaky as a result of local pressure forcing a filtrate of plasma without large proteins which is shortlived.

Exudation : soon after, changes in the blood vessel endothelial cells occur, and plasma with large protein molecules including clotting and immunological proteins escapes.

Nakaguchi et al[17] have studied the various stages of Chronic SDH with regard to CT findings. Homogenous stage: hypodense and isodense hematomas develop continuously into hyperdense hematomas. Laminar stage: a hyperdense laminar structure runs along the inner membrane. Separated stage**:** as hematoma matures, it separates into two components that the head motion cannot homogenize. Trabecular stage: hematoma density changes from an isodense to a hypodense signal on CT.

Nomura et al.[17] have studied the chronological appearance of Chronic SDH in CT which are as follows: hypodense, isodense, hyperdense, layered, and mixed-density lesions. Mixed density hematomas were encountered more in patients with Grade 2 and Grade 3 patients. Hypodensity hematomas were more frequently seen in Grade 1 and Grade 0 patients. Fujisawa et al, found that protein concentrations were higher in Chronic SDHs with hyperdense hematomas. Laminar or mixed density hematomas showed a higher tendency to recur.

Clinical presentation :

In the pre-CT era, chronic SDH was called "the imitator" because of its varied presentations. Clinical presentation is often insidious, with symptoms that include decreased level of consciousness, headache, difficulty with gait or balance, cognitive dysfunction or memory loss, motor deficit (eg. Hemiparesis) or aphasia. Misdiagnosis included :

- Dementia
- Stroke
- TIA
- Tumor
- Subarachnoid Hemorrhage
- Meningitis/encephalitis

Contributing factors for misdiagnosis :

- Insiduous course of the illness
- Lack of H/O Head injury, only one quarter to one half of the patients give a history of trauma.

Neurological examination may demonstrate mental status changes, hemiparesis, papilloedema, hyperreflexia or reflex asymmetry, hemianopia, or third or sixth cranial nerve dysfunction. In patients older than 60 years or older, hemiparesis and reflex asymmetry are common presenting signs. In patients younger than 60 years, headache is a common presenting symptom. Markwalder[14] grading system is currently used in classifying patients with Chronic SDH

Markwalder's Neurologic Grading System

Grade 0	Patient neurologically stable
Grade 1	Patient alert and oriented; mild symptoms, such as headache; absent or mild symptoms or neurological deficit such as reflex asymmetry
Grade 2	Patient drowsy or disoriented with variable neurological deficit, such as hemiparesis
Grade 3	Patient stuporous but responding appropriately to noxious stimuli; severe focal signs, such as hemiplegia
Grade 4	Patient comatose with absent motor response to painful stimuli; decerebrate or decorticate posturing

INVESTIGATIONS

Laboratory studies :

To determine if defective coagulation was involved in the formation of the subdural hematoma (SDH) and to guide correction of any coagulation abnormalities.

Tests performed : prothrombin time, activated thromboplastin time (aPTT) and a platelet count.

Bleeding time assessment may reveal platelet dysfunction.

Imaging studies :

CT of the head (without contrast)

Diagnostic procedure of choice

Appearance of SDH varies with age of the clot

Suspected when the interface between cortical gray matter and the underlying white matter is seen to be well away from the inner table.

Nomura et al[17] classified Chronic SDH into five groups according to their appearance on computerized tomography: high density,

Isodensity, low density, mixed density and layering types.

The concentration of fibrinogen, which indicates rebleeding, is higher in the mixed density (15.7 ± 3.4 mg/dl) and layering types of hematomas, and lower in the low density hematomas (1.4 ± 0.6 mg/dl) compared with the isodense hematomas (6.9 ± 1.1 mg/dl). The layering type is active with a high tendency to rebleed and for hyperfibrinolytic activity. The mixed density type has a high tendency to rebleed with lower fibrinolytic activity than the layering type. The low density hematoma is stable with a low tendency to rebleed and low fibrinolytic activity.

Magnetic Resonance Imaging :

An MRI is helpful in imaging chronic SDH when CT scans are difficult to interpret (eg. When suspecting an isodense hematoma).

MRI may be particularly helpful in diagnosing bilateral Chronic SDH because a midline shift may not be apparent on CT scan.

Various stages of hematoma as seen in MRI :

Stage	Age	Condition of Hb	T1WI	T2WI
Hyperacute	<24hours	OxyHb(intracellular	Iso	hyper
Acute	1-3 days	De oxy Hb (intra)	Hypo	Hypo
Subacute				
Early	> 3 days	Meth Hb(intra)	Hyper	Hypo
Late	> 7 days	Meth Hb(extra)	Hyper	Hyper
Chronic	> 14 days			
Center		Hemichromes(extra)	Iso	Hyper
Rim		Hemosiderin(intra)	Hypo	Hypo

Angiography :

Indicated in the absence of clear history of trauma

Angiographic signs – avascular zone between skull and brain with away dislocation of major vessels.

Treatment :

Indications for treatment : A Chronic SDH which is causing significant mass effect with neurological deficit needs to be evacuated.

Various treatment options are available for the treatment of Chronic SDH:

1. Burrhole and evacuation(single or double with or without drain
2. Twist drill craniostomy
3. Craniotomy and evacuation with or without membranectomy.

The choice of the procedure depends on the surgeon and the characteristics of the SDH.

1. Burrhole evacuation of Chronic SDH : procedure of choice. Done under local or general anaesthesia. Single or double burrholes are used. If a single burrhole is used, it is usually made over the thickest part of the SDH, mostly at the parietal eminence. If double burrholes are used, the burrholes are placed in such a way that they can be incorporated into a frontotemporoparietal craniotomy flap. Dura is coagulated and opened in a cruciate fashion; further coagulation causes edges to retract. Ventricular catheter is placed in the subdural space. Residual hematoma is gently irrigated with saline until irrigant is clear. Catheter is redirected to different areas of subdural space to irrigate hematoma.

Drainage may be blocked if the burrholes are placed too close to the edge of the hematoma in which case the brain may be retracted using a brain retractor. Often brain does not resurface right away- tunnel catheter under skin and leave as subdural drain.

2. Twist drill craniotomy[6] **–** hole is drilled at 45º angle to skull over thickest part of hematoma (unless this lies over motor strip) possible under local anaesthesia. Thin rubber catheter is gently guided into subdural space, tunneled under scalp, and brought out through stab incision (connect to closed drainage system without suction for 24- 72 hours).

3. Craniotomy – indicated for multilocular/ calcified SDHs and burrhole /twist drill failures. Patients are nursed in supine position for 2 to 3 days with adequate hydration so as to facilitate the brain to expand. CT often shows residual subdural collection but should be left alone unless it is causing mass effect.

If SDH recurs after burrhole drainage – craniotomy with excision of membranes or shunting of subdural cavity into pleural or peritoneal cavity.

Post operative seizures are reported in 3-10% patients , many surgeons use anticonvulsants prophylactically for one month after operation.

Use of drains:

Santarius et al[23] have concluded that use of a drain after burrhole drainage of Chronic SDH is safe and associated with reduced recurrence and mortality at 6 months.

Single or double burrhole :

Han et al[8] concluded that single burr hole drainage for Chronic SDH is equally efficient with low recurrence rate.

Twist drill craniostomy :

Bozkurt et al[6] have concluded that the major advantage of this technique is that it can be performed at the patient’s bedside with the use of local anesthesia. Suitable for elderly or otherwise medically frail patients who pose a high anaesthesia and operative risk and also for other patients suffering from chronic SDH as a first and minimally invasive attempt.

Lee et al[10] in their study had concluded that an extended surgical approach with partial membranectomy has no advantages regarding the rate of reoperation and the outcome. As initial treatment, burrhole drainage with irrigation of the hematoma cavity and closed system drainage is recommended. Extended craniotomy with membranectomy is now reserved for instances of acute rebleeding with solid hematoma.

Aung et. al[3]. had developed a technique of performing burrhole drainage, irrigation and replacement of the hematoma with Hartmann's solution, and closed drainage of the subcural space with a silicone catheter. They say that persistent intracranial air can cause a deterioraton in the level of consciousness or seizures in the post operative period. Further cerebral infarction can develop a few days after surgery because of the intracranial hypotension that occurs during the drainage procedure.

Weigel et al[27]. in their paper titled "Outcome of contemporary surgery for Chronic SDH: evidence based review", have concluded that the three principal techniques – twist drill craniostomy, burrhole craniostomy and craniotomy – used in contemporary neurosurgery for Chronic SDH have different profiles for morbidity, mortality, recurrence rate, and cure rate. Twist drill and burrhole craniostomy can be considered first tier treatment, while craniotomy may be used as second tier treatment. A cumulative summary of data shows that, overall, the postoperative outcome of Chronic SDH has not improved substantially over the past 20 years.

Krupp and Jans[11] have concluded that the factors that did not have a significant effect on the outcome included whether the SDH formation was bilateral or unilateral, the extent of neomembranous organization of the hematoma, and the amount of primary cerebral expansion following decompression.

Adeleye et al.[1] has reported a single case of chronic SDH with significant mass effect(20mm thick and 10mm midline shift), treated conservatively with oral dexamethasone 2mg every 12 hours for 5 days. There was dramatic clinical improvement and nearly complete radiological resolution in 5 weeks. The mechanism by which steroids aid in the resorption of Chronic SDH is still not clear and might well have represented another example of spontaneous resolution of the hematoma.

In patients who have no significant mass effect on imaging studies and no neurological symptoms or signs except mild headache, Chronic SDHs have been observed with serial scans and have been seen to remain stable or to resolve.

Although hematoma resolution has been reported, it cannot be reliably predicted, and no medical therapy has been shown to be effective in expediting the resolution of Chronic SDHs.

Follow up :

Serial neurological examinations are used and coagulation parameters may need to be followed. Serial CTs are used to document the resolution of the Chronic SDH.

If the patient was on anticoagulant therapy preoperatively, when to restart anticoagulation therapy is complicated. No solution is perfect. The risks and benefits of anticoagulation must be weighed against the risks or rebleeding to determine when to restart therapy.

Complications:

Among patients with Chronic SDH who underwent surgical drainage, 5.4 – 19% experienced medical or surgical complications. Medical complications, including seizures, pneumonia, empyema, and other infections, occurred in 16.9% of cases. Surgical complications, including acute SDH formation, intraparenchymal hematoma, or tension pneumocephalus, occurred in 2.3% of cases.

After surgery for Chronic SDH even with normalization of ICP, a persistent space may exist between the brain and the dura, since the brain may not expand to fill this space. Residual hematoma has been found on

92% of postoperative CT scans within 4 days of operation; however, clinical improvement may proceed regardless of this collection.

Reoperation rates for reaccumulation of hematoma have been reported to be from 12-22%. When the reoperation for burrhole drainage was compared with craniotomy drainage, similar rates of 18.5% and 12.5% were found.

Post operative seizures have been reported in 3-10% of patients. Whether prophylactic anticonvulsants can decrease this risk is debatable. Subdural empyema, brain abscess, and meningitis have been reported to occur in less than 1% of patients after operative drainage of a Chronic SDH. In these patients, numerous potential complications are also related to anesthesia, hospitalization, patient age, and concurrent medical conditions.

Current Study

It is evident from the above that a single burrhole drainage itself maybe an effective method of treatment of Chronic SDH. This is probably the first attempt in Indian population, comparing the single burrhole drainage and double burrhole drainage methods.

MATERIALS AND METHODS

This study was conducted between April 2009 and February 2011 at the Institute of Neurology, Rajiv Gandhi Government General Hospital, Chennai. The geographical area of distribution of the patients was North Tamilnadu and Southern Andhra Pradesh.

All the patients admitted with the diagnosis of chronic subdural hematoma (SDH) were included in the study.

These patients belonged to one of the three groups:

a) Referred from private institution with the CT scan diagnosis of Chronic SDH

b) Admitted in the medical wards with headache or weakness of limbs with CT scan revealing a chronic Subdural hematoma.

c) Patients with small acute subdural hematoma treated conservatively and in whom the hematoma evolved into CSDH.

The total number of patients treated during the study period was 107.

The following groups of CSDH patients were not included in the study:

Patients with

1. Bleeding disorders and coagulopathy
2. Bilateral chronic subdural hematoma
3. Patients who died before surgery

4. Patients who had other associated life threatening co-morbid conditions.

As per the above exclusion criteria, a total of 11 patients were excluded from the study group and 96 patients qualified to undergo the study.

Detailed history regarding aspirin intake, coagulation disorders, and co morbid conditions such as hypertension, diabetes mellitus, and alcoholism were recorded.

The study group was examined and analysed based on the clinical features and radiological imaging findings

Clinically patients were categorized using

1. The Glasgow Coma Scale (GCS) and

2. The Markwalder Chronic Subdural Hematoma Scale.

Markwalder Chronic Subdural Hematoma Scale

Grade 0	Patient neurologically stable
Grade 1	Patient alert and oriented; mild symptoms, such as headache; absent or mild symptoms or neurological deficit such as reflex asymmetry
Grade 2	Patient drowsy or disoriented with variable neurological deficit, such as hemiparesis
Grade 3	Patient stuporous but responding appropriately to noxious stimuli; severe focal signs, such as hemiplegia
Grade 4	Patient comatose with absent motor response to painful stimuli; decerebrate or decorticate posturing

Diagnosis was confirmed with the plain Computerised Tomography of the brain. The following parameters in the CT were noted

1. Thickness of the hematoma,
2. Midline shift and
3. Density of the hematoma, whether iso, hypo, hyper or heterodense with layering were noted.

Bleeding time, clotting time, prothrombin time, and INR were done,.complete blood count and liver function test were done for all the patients and recorded.

All the patients were operated on an emergency basis under general anaesthesia after obtaining proper consent.

Selection of the patients for single or double burrhole technique was non randomized and was left to the neurosurgeon’s preference.

Single burrhole technique : One burrhole to be made over the point of maximum thickness of the hematoma. Dura was cauterized and opened widely. Immediately after opening the dura No. 12 silastic catheter which was already tunneled subcutaneously was inserted into the subdural space and connected to a closed drain (Intercostal Drainage bag). No subdural wash was given. The catheter was secured to the skin and wound closed in layers

Double burrhole technique : Two burrholes are placed. The frontal burrhole was made in the midpupillary line half an inch in front of the coronal suture. The parietal burrhole was placed just posterior and inferior to the parietal eminence. The incisions were made in such a way that they can be incorporated in a craniotomy flap if needed. Dura was cauterized and opened widely, the subdural hematoma was allowed to drain spontaneously. A thorough wash of the cavity was done from both burrhole with normal saline. A latex rubber drain was placed in both the burrholes, tunneled subcutaneously and brought out through a separate incision. Both drains were secured to the skin and wounds closed in layers.

In the postoperative period patients were nursed in the supine position for three days and adequately hydrated with oral as well as intravenous fluids to facilitate expansion of the brain. Routine antibiotics were given preop and postoperatively. Anticonvulsants were used in all the patients and continued postoperatively for a period of 3 months. Drains were removed on the 2^{nd} postoperative day. All the patients were followedup with CT scan of the brain taken on the 4th postoperative day. The CT scan was perused for residual hematoma and midline shift. The findings were recorded. Presence of pneumocephalus was categorized as :

1. Nil - when no air is seen
2. Minimal - when a few air pockets < 1cc is persent
3. Moderate- when significant air is seen but without mass effect

4. Severe - when significant air with mass effect is seen.

The following parameters were recorded for analysis:

Clinical :

Glasgow coma scale

Mark Walder chronic subdural hematoma scale which takes into account the symptoms such as headache, vomiting, as well as signs such as weakness and altered sensorium.

Based on the CT scan findings, persistant midline shift of > 5 mm and /or residual hematoma thickness >10 mm was considered as indication for reexploration.these patients underwent second surgery with the same operative technique they were subjected to in the first surgery. The second surgery was also done as an emergency. The second surgery were followed up in the same manner, a fourth day CT scan of the brain was done after the second surgery and was analysed for midline shift, thickness of the residual hematoma and pneumocephalus.

All the patients were discharged one day after suture removal and followed up periodically every four weeks for a total period of six months.

A detailed proforma including all the aspects of preoperative status, operative technique, postoperative events and followup findings was prepared for each and every patient separately. The model proforma is shown in appendix 1.

Based on the proformas, a master chart was prepared including all the patients and relevant findings(vide appendix 2). The master chart was subjected to a detailed statistical analysis using the student t-test and chi-square test using SPSS software (version 12.0; SPSS Inc). Results with a p-value of < 0.05 was considered significant.

RESULTS

A total of 96 patients underwent the study, out of which 7 were females and 89 were males. 46 patients underwent surgery with single burrhole technique(group 1) and 50 patients underwent the double burrhole technique(group 2). The average age of patients in group-1 was 58.48 years and that of group-2 was 58.25 years.

The average preoperative GCS score in group-1 was 13.04 and in group-2 was 13.06. while the average Markwalder grade

was 1.82 in group1 and 1.81 in group2.

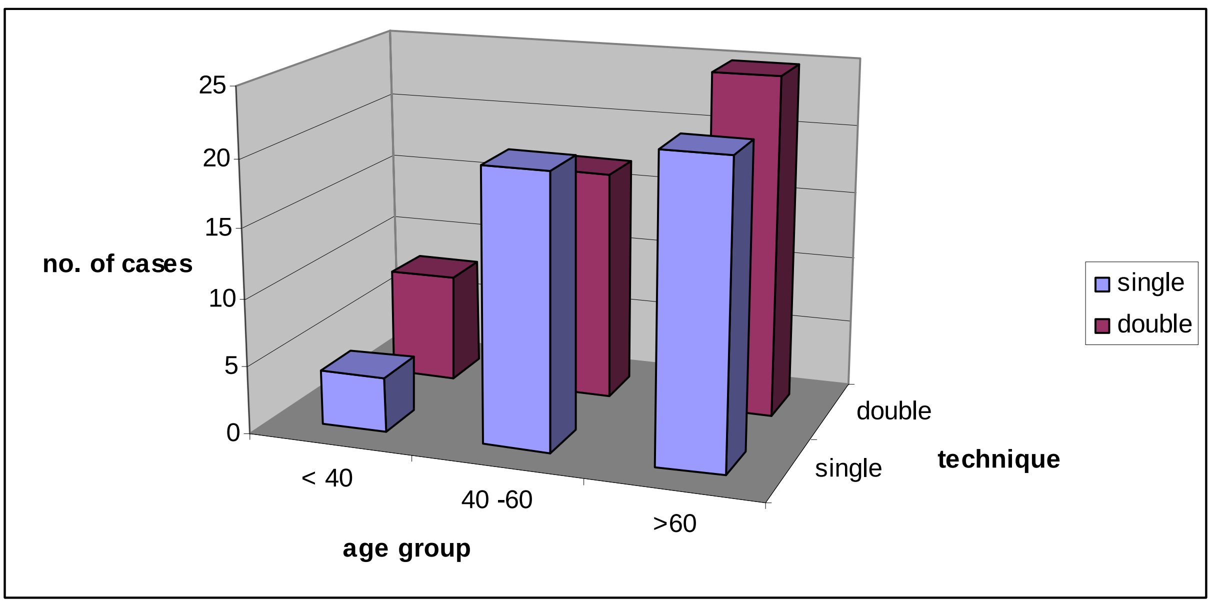
The following table gives tne average SDH thickness and midline shift between the two groups:

Table:1

Technique	Average thickness of SDH mm	Residual SDH mm	Average reduction	Midline shift preop	Midline shift postop	Reduction In shift
Single	17.53	5.23	12.35	8.64	1.22	7.42
Double	17.54	5.22	12.28	8.55	1.21	7.34

Table : 2 Analysis of age distribution

Age group	single	double	Total
< 40	4	8	12
40 -60	20	17	37
>60	22	25	47
total	46	50	96

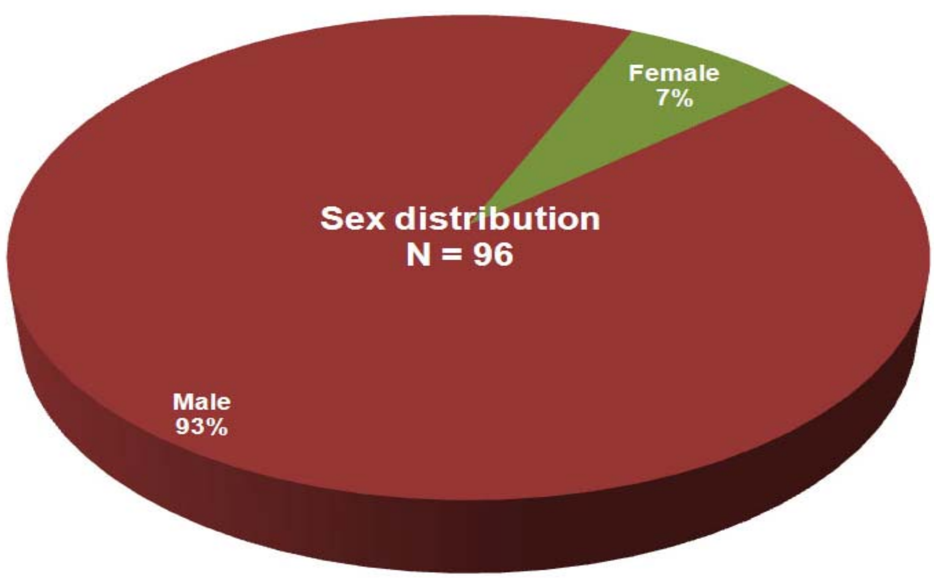


88% of the total number of patients were above 40 years of age.

The distribution of single and double burrhole techniques among the age groups were almost equal.

Table : 3 Distribution of sex group

Sex group	No	%
Male	89	92.7%
Female	7	7.3%



Spectrum of symptoms

Table : 4

Symptoms	No	%
Weakness	57	59.4%
Altered sensorium	53	55.2%
HA	50	52.1%
Vomiting	26	27.1%
Seizures	2	2.1%

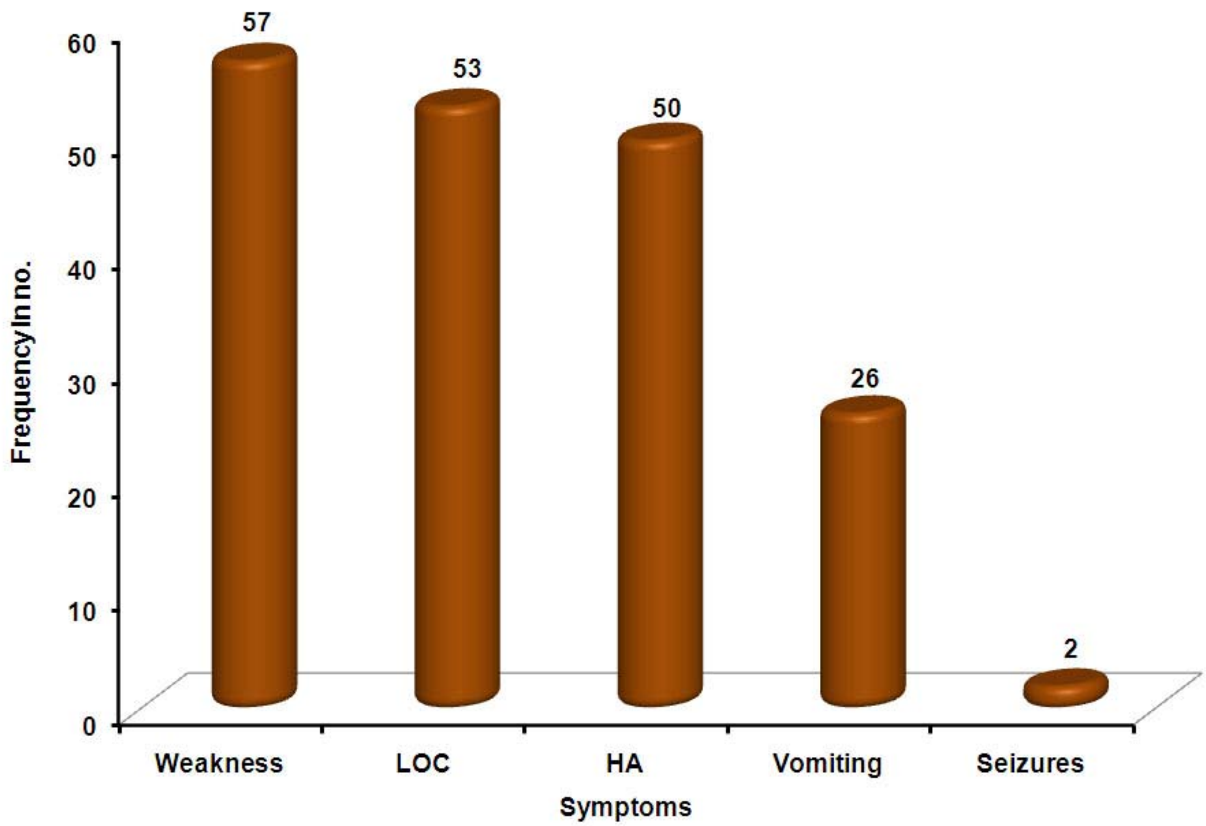


Table : 5 Single – Markwalder

Paired Samples Statistics				
Markwalder	**Mean**	**N**	**Std. Deviation**	**P - value**
BEFORE	1.83	46	0.739	0.000
AFTER	0.76	46	0.822	

Table : 6 Double – Markwalder

Paired Samples Statistics				
Markwalder	**Mean**	**N**	**Std. Deviation**	**P - value**
BEFORE	1.80	50	0.756	0.000
AFTER	0.80	50	0.948	

Table : 7 Single – GCS

Paired Samples Statistics				
GCS	**Mean**	**N**	**Std. Deviation**	**P – value**
BEFORE	12.98	46	2.809	0.000
AFTER	14.46	50	1.471	

Table : 8 Double – GCS

Paired Samples Statistics				
GCS	**Mean**	**N**	**Std. Deviation**	**P – value**
BEFORE	13.14	50	2.983	0.000
AFTER	14.14	50	2.507	

Table : 9

Markwalder				
Type	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Single	46	0.76	0.82	0.12
Double	50	0.80	0.95	0.13

Table : 10 **Independent Samples Test**

t-test for Equality of Means					
Markwalder	t	Df	P – value	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	-.215	94	.830	-.39994	.32168
Equal variances not assumed	-.217	93.682	.829	-.39781	.31955

Comparing Mark Walder scales for single and double burrhole techniques : P-value is 0.830 (< 0.05), there is no significant difference between the two procedures.

Comparing Glasgow Coma Scales between single and double burrhole.

Table : 11

Glasgow Coma Scale				
Type	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Single	46	14.456	1.471	0.22
Double	50	14.14	2.507	0.35

Table : 12 **Independent Samples Test**

t-test for Equality of Means					
GCS scale	t	Df	P – value	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	0.746	94	0.458	-0.526	1.159
Equal variances not assumed	0.761	80.297	0.449	-0.511	1.144

Comparing Glasgow Coma Scales between single and double burrhole techniques : P- value is 0.458 (< 0.05), showing no significant difference between the two techniques.

Reduction in hematoma thickness after surgery

Table : 13

Reduction in thickness(mm)	Type		Total
	Single	Double	
4	0	1	1
5	0	2	2
6	2	2	4
7	0	4	4
8	4	3	7
9	6	2	8
10	5	4	9
11	4	6	10
12	6	6	12
13	3	3	6
14	2	2	4
15	3	5	8
16	3	2	5
17	1	2	3
18	3	1	4
19	0	1	1
20	2	3	5
21	1	1	2
23	1	0	1
Total	46	50	96

Table : 14

Chi-Square Tests			
	Value	df	P-value
Pearson Chi-Square	13.744	18	0.746

Comparing the difference in thickness of the hematoma before and after single and double burrhole techniquesP- value =0.746 (< 0.05), showing no difference between the two procedures.

Reduction in midline shift after treatment

Table : 15

Reduction in midline shift (mm)	Type		Total
	Single	Double	
0	0	3	3
2	4	4	8
3	6	2	8
4	2	2	4
5	4	8	12
6	3	3	6
7	4	1	5
8	1	7	8
9	5	2	7
10	6	8	14
11	3	3	6
12	7	4	11
13	1	2	3
14	0	1	1
Total	46	50	96

Table : 16

Chi-Square Tests			
	Value	df	P-value
Pearson Chi-Square	16.21777	13	0.237

Comparing the reduction of midline shift between single and double burrhole techniques P- value is 0.237 (< 0.05). No difference between the two procedures.

RESULTS : PNEUMOCEPHALUS

Table : 17

Drain	Pneumocephalus			Total
	Moderate	Minimal	Nil	
Single	1	10	35	46
Double	4	12	34	50
Total	5	22	69	96

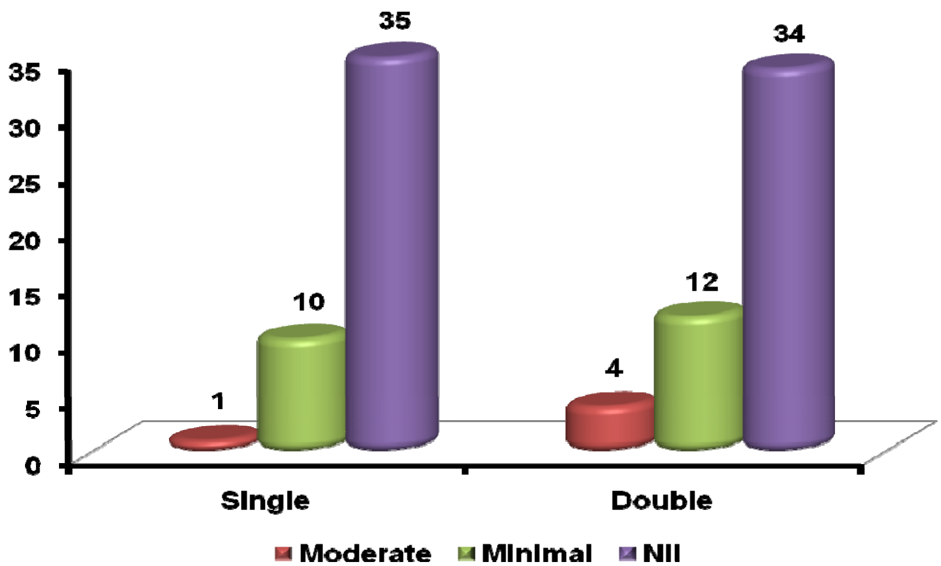


Table : 18

t-test for Equality of Means					
Pneumocephalus	t	df	P - value	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	.118	94	0.906	-.220	.248
Equal variances not assumed	.118	91.8	0.907	-.221	.249

RESULTS : RETAPPING

Table : 19

Retapping		
Type	**Yes**	**No**
Single	4	42
Double	4	46

Table : 20 Independent Samples Test

t-test for Equality of Means					
Retapping	T	df	P - value	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	0.122	94	0.903	-.106	.120
Equal variances not assumed	-.122	92.6	0.903	-.107	0.120

A p-value of 0.903 (< 0.05) indicates that there is no statistically significant difference between the two procedures.

MATERIALS AND METHODS

This study was conducted between April 2009 and February 2011 at the Institute of Neurology, Rajiv Gandhi Government General Hospital, Chennai. The geographical area of distribution of the patients was North Tamilnadu and Southern Andhra Pradesh.

All the patients admitted with the diagnosis of chronic subdural hematoma (SDH) were included in the study.

These patients belonged to one of the three groups:

a) Referred from private institution with the CT scan diagnosis of Chronic SDH
b) Admitted in the medical wards with headache or weakness of limbs with CT scan revealing a chronic Subdural hematoma.
c) Patients with small acute subdural hematoma treated conservatively and in whom the hematoma evolved into CSDH.

The total number of patients treated during the study period was 107.

The following groups of CSDH patients were not included in the study:

Patients with

1. Bleeding disorders and coagulopathy
2. Bilateral chronic subdural hematoma
3. Patients who died before surgery

4. Patients who had other associated life threatening co-morbid conditions.

As per the above exclusion criteria, a total of 11 patients were excluded from the study group and 96 patients qualified to undergo the study.

Detailed history regarding aspirin intake, coagulation disorders, and co morbid conditions such as hypertension, diabetes mellitus, and alcoholism were recorded.

The study group was examined and analysed based on the clinical features and radiological imaging findings

Clinically patients were categorized using

1. The Glasgow Coma Scale (GCS) and

2. The Markwalder Chronic Subdural Hematoma Scale.

Markwalder Chronic Subdural Hematoma Scale

Grade 0	Patient neurologically stable
Grade 1	Patient alert and oriented; mild symptoms, such as headache; absent or mild symptoms or neurological deficit such as reflex asymmetry
Grade 2	Patient drowsy or disoriented with variable neurological deficit, such as hemiparesis
Grade 3	Patient stuporous but responding appropriately to noxious stimuli; severe focal signs, such as hemiplegia
Grade 4	Patient comatose with absent motor response to painful stimuli; decerebrate or decorticate posturing

Diagnosis was confirmed with the plain Computerised Tomography of the brain. The following parameters in the CT were noted

1. Thickness of the hematoma,
2. Midline shift and
3. Density of the hematoma, whether iso, hypo, hyper or heterodense with layering were noted.

Bleeding time, clotting time, prothrombin time, and INR were done,.complete blood count and liver function test were done for all the patients and recorded.

All the patients were operated on an emergency basis under general anaesthesia after obtaining proper consent.

Selection of the patients for single or double burrhole technique was non randomized and was left to the neurosurgeon’s preference.

Single burrhole technique : One burrhole to be made over the point of maximum thickness of the hematoma. Dura was cauterized and opened widely. Immediately after opening the dura No. 12 silastic catheter which was already tunneled subcutaneously was inserted into the subdural space and connected to a closed drain (Intercostal Drainage bag). No subdural wash was given. The catheter was secured to the skin and wound closed in layers

Double burrhole technique : Two burrholes are placed. The frontal burrhole was made in the midpupillary line half an inch in front of the coronal suture. The parietal burrhole was placed just posterior and inferior to the parietal eminence. The incisions were made in such a way that they can be incorporated in a craniotomy flap if needed. Dura was cauterized and opened widely, the subdural hematoma was allowed to drain spontaneously. A thorough wash of the cavity was done from both burrhole with normal saline. A latex rubber drain was placed in both the burrholes, tunneled subcutaneously and brought out through a separate incision. Both drains were secured to the skin and wounds closed in layers.

In the postoperative period patients were nursed in the supine position for three days and adequately hydrated with oral as well as intravenous fluids to facilitate expansion of the brain. Routine antibiotics were given preop and postoperatively. Anticonvulsants were used in all the patients and continued postoperatively for a period of 3 months. Drains were removed on the 2nd postoperative day. All the patients were followedup with CT scan of the brain taken on the 4th postoperative day. The CT scan was perused for residual hematoma and midline shift. The findings were recorded. Presence of pneumocephalus was categorized as :

1. Nil - when no air is seen
2. Minimal - when a few air pockets < 1cc is persent
3. Moderate- when significant air is seen but without mass effect

4. Severe - when significant air with mass effect is seen.

The following parameters were recorded for analysis:

Clinical :

Glasgow coma scale

Mark Walder chronic subdural hematoma scale which takes into account the symptoms such as headache, vomiting, as well as signs such as weakness and altered sensorium.

Based on the CT scan findings, persistant midline shift of > 5 mm and /or residual hematoma thickness >10 mm was considered as indication for reexploration.these patients underwent second surgery with the same operative technique they were subjected to in the first surgery. The second surgery was also done as an emergency. The second surgery were followed up in the same manner, a fourth day CT scan of the brain was done after the second surgery and was analysed for midline shift, thickness of the residual hematoma and pneumocephalus.

All the patients were discharged one day after suture removal and followed up periodically every four weeks for a total period of six months.

A detailed proforma including all the aspects of preoperative status, operative technique, postoperative events and followup findings was prepared for each and every patient separately. The model proforma is shown in appendix 1.

Based on the proformas, a master chart was prepared including all the patients and relevant findings(vide appendix 2). The master chart was subjected to a detailed statistical analysis using the student t-test and chi-square test using SPSS software (version 12.0; SPSS Inc). Results with a p-value of < 0.05 was considered significant.

RESULTS

A total of 96 patients underwent the study, out of which 7 were females and 89 were males. 46 patients underwent surgery with single burrhole technique(group 1) and 50 patients underwent the double burrhole technique(group 2). The average age of patients in group-1 was 58.48 years and that of group-2 was 58.25 years.

The average preoperative GCS score in group-1 was 13.04 and in group-2 was 13.06. while the average Markwalder grade

was 1.82 in group1 and 1.81 in group2.

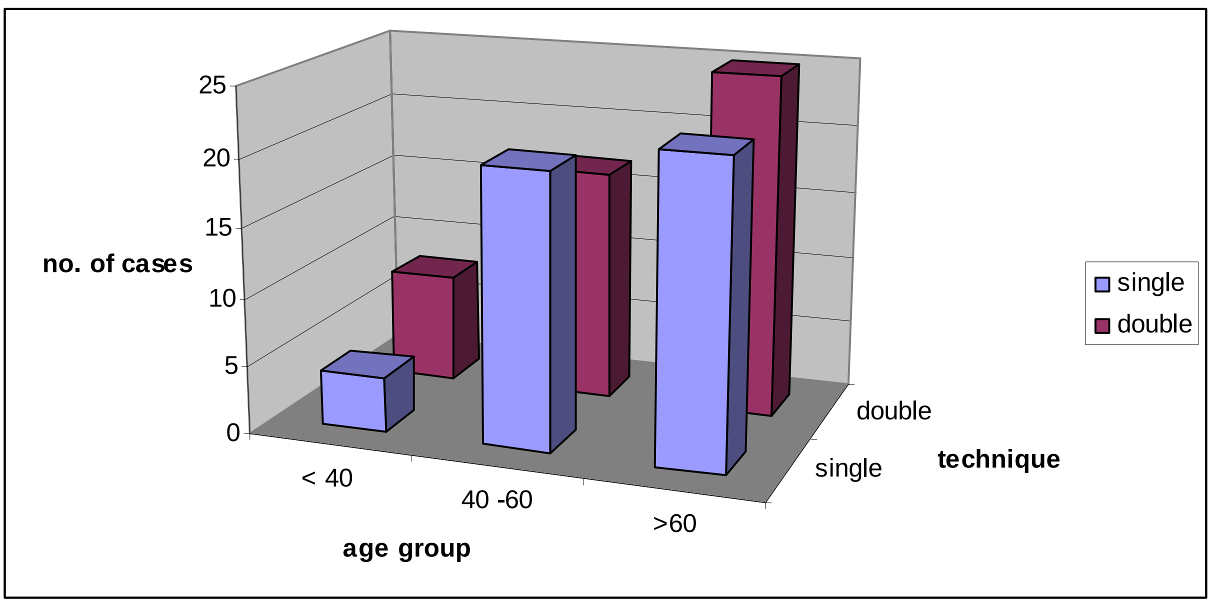
The following table gives tne average SDH thickness and midline shift between the two groups:

Table:1

Technique	Average thickness of SDH mm	Residual SDH mm	Average reduction	Midline shift preop	Midline shift postop	Reduction In shift
Single	17.53	5.23	12.35	8.64	1.22	7.42
Double	17.54	5.22	12.28	8.55	1.21	7.34

Table : 2 Analysis of age distribution

Age group	single	double	Total
< 40	4	8	12
40 -60	20	17	37
>60	22	25	47
total	46	50	96

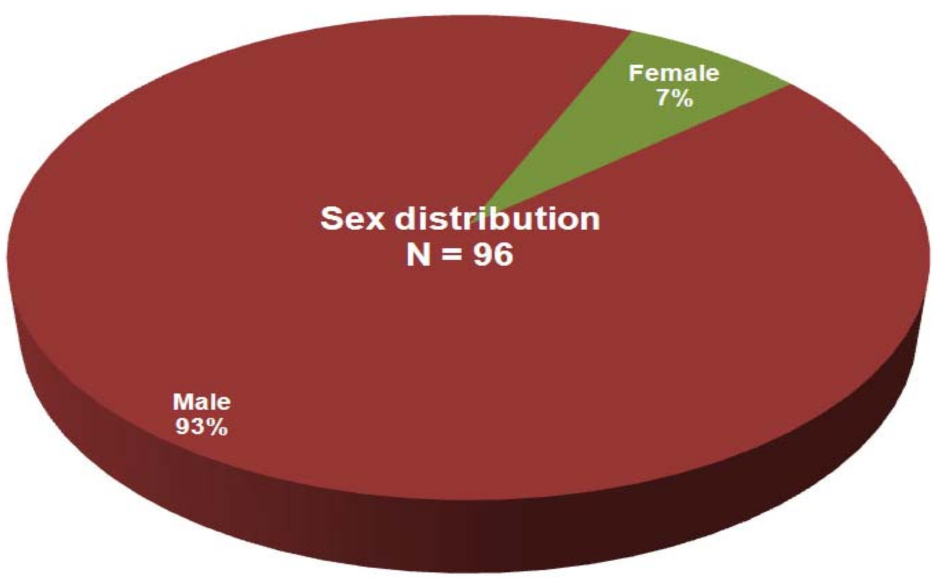


88% of the total number of patients were above 40 years of age.

The distribution of single and double burrhole techniques among the age groups were almost equal.

Table : 3 Distribution of sex group

Sex group	No	%
Male	89	92.7%
Female	7	7.3%



Spectrum of symptoms

Table : 4

Symptoms	No	%
Weakness	57	59.4%
Altered sensorium	53	55.2%
HA	50	52.1%
Vomiting	26	27.1%
Seizures	2	2.1%

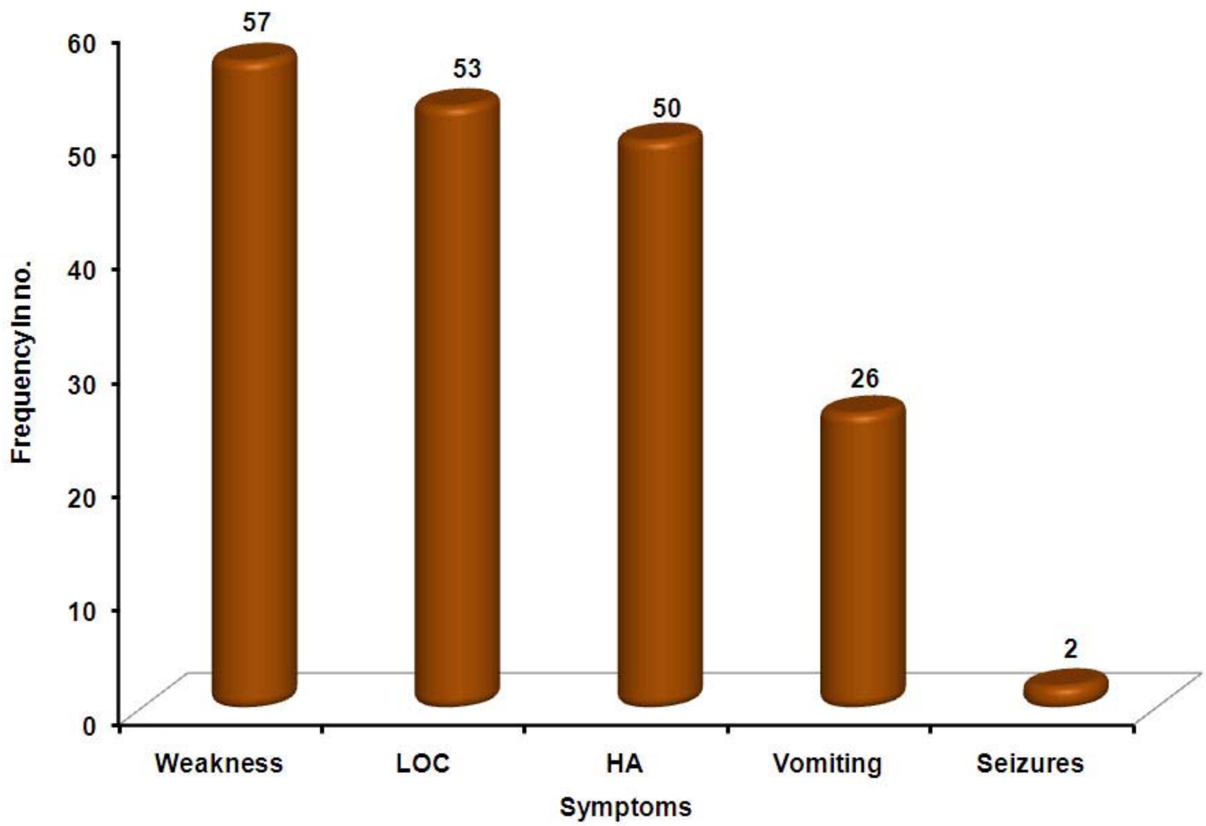


Table : 5   Single – Markwalder

Paired Samples Statistics				
Markwalder	**Mean**	**N**	**Std. Deviation**	**P - value**
BEFORE	1.83	46	0.739	0.000
AFTER	0.76	46	0.822	

Table : 6   Double – Markwalder

Paired Samples Statistics				
Markwalder	**Mean**	**N**	**Std. Deviation**	**P - value**
BEFORE	1.80	50	0.756	0.000
AFTER	0.80	50	0.948	

Table : 7   Single – GCS

Paired Samples Statistics				
GCS	**Mean**	**N**	**Std. Deviation**	**P – value**
BEFORE	12.98	46	2.809	0.000
AFTER	14.46	50	1.471	

Table : 8   Double – GCS

Paired Samples Statistics				
GCS	**Mean**	**N**	**Std. Deviation**	**P – value**
BEFORE	13.14	50	2.983	0.000
AFTER	14.14	50	2.507	

Table : 9

Markwalder				
Type	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Single	46	0.76	0.82	0.12
Double	50	0.80	0.95	0.13

Table : 10 **Independent Samples Test**

t-test for Equality of Means					
Markwalder	t	Df	P – value	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	-.215	94	.830	-.39994	.32168
Equal variances not assumed	-.217	93.682	.829	-.39781	.31955

Comparing Mark Walder scales for single and double burrhole techniques : P-value is 0.830 (< 0.05), there is no significant difference between the two procedures.

Comparing Glasgow Coma Scales between single and double burrhole.

Table : 11

Glasgow Coma Scale				
Type	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Single	46	14.456	1.471	0.22
Double	50	14.14	2.507	0.35

Table : 12 **Independent Samples Test**

t-test for Equality of Means					
GCS scale	t	Df	P – value	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	0.746	94	0.458	-0.526	1.159
Equal variances not assumed	0.761	80.297	0.449	-0.511	1.144

Comparing Glasgow Coma Scales between single and double burrhole techniques : P- value is 0.458 (< 0.05), showing no significant difference between the two techniques.

Reduction in hematoma thickness after surgery

Table : 13

Reduction in thickness(mm)	Type		Total
	Single	Double	
4	0	1	1
5	0	2	2
6	2	2	4
7	0	4	4
8	4	3	7
9	6	2	8
10	5	4	9
11	4	6	10
12	6	6	12
13	3	3	6
14	2	2	4
15	3	5	8
16	3	2	5
17	1	2	3
18	3	1	4
19	0	1	1
20	2	3	5
21	1	1	2
23	1	0	1
Total	46	50	96

Table : 14

Chi-Square Tests			
	Value	df	P-value
Pearson Chi-Square	13.744	18	0.746

Comparing the difference in thickness of the hematoma before and after single and double burrhole techniquesP- value =0.746 (< 0.05), showing no difference between the two procedures.

Reduction in midline shift after treatment

Table : 15

Reduction in midline shift (mm)	Type		Total
	Single	Double	
0	0	3	3
2	4	4	8
3	6	2	8
4	2	2	4
5	4	8	12
6	3	3	6
7	4	1	5
8	1	7	8
9	5	2	7
10	6	8	14
11	3	3	6
12	7	4	11
13	1	2	3
14	0	1	1
Total	46	50	96

Table : 16

Chi-Square Tests			
	Value	df	P-value
Pearson Chi-Square	16.21777	13	0.237

Comparing the reduction of midline shift between single and double burrhole techniques P- value is 0.237 (< 0.05). No difference between the two procedures.

RESULTS : PNEUMOCEPHALUS

Table : 17

Drain	Pneumocephalus			Total
	Moderate	Minimal	Nil	
Single	1	10	35	46
Double	4	12	34	50
Total	5	22	69	96

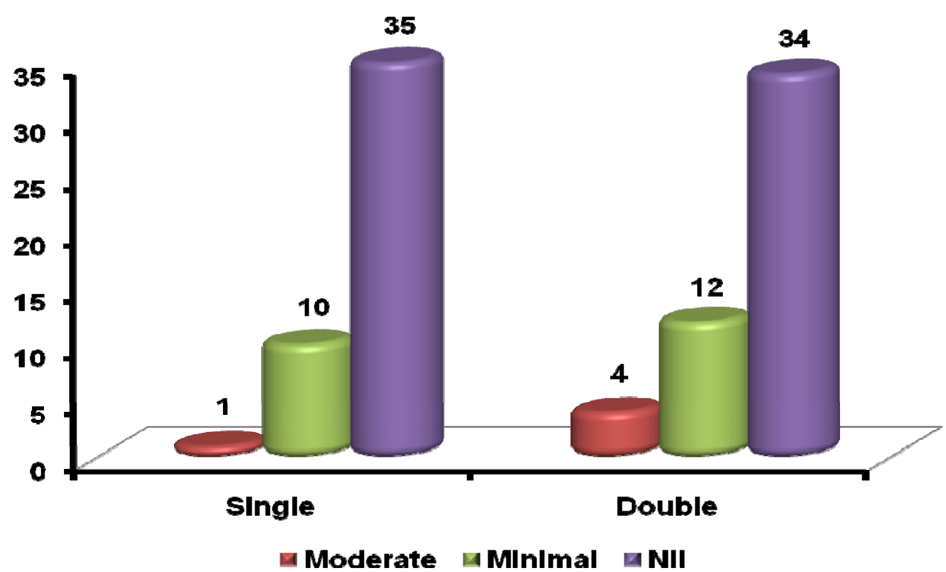


Table : 18

t-test for Equality of Means					
Pneumocephalus	t	df	P - value	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	.118	94	0.906	-.220	.248
Equal variances not assumed	.118	91.8	0.907	-.221	.249

RESULTS : RETAPPING

Table : 19

Retapping		
Type	**Yes**	**No**
Single	4	42
Double	4	46

Table : 20 Independent Samples Test

t-test for Equality of Means					
Retapping	T	df	P - value	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	0.122	94	0.903	-.106	.120
Equal variances not assumed	-.122	92.6	0.903	-.107	0.120

A p-value of 0.903 (< 0.05) indicates that there is no statistically significant difference between the two procedures.

DISCUSSION

Chronic subdural hematoma is a common clinical entity faced by neurosurgeons in their daily practice. The increase in the subdural space in older people as a result of decreased brain mass is one of the most important reasons for the problem. Improvements in medical technology has given rise to increasing population of older people and hence the incidence of chronic subdural hematoma is increasing. Elderly people also suffer from co-morbid medical problems such hypertension, diabetes, ischaemic heart disease and pulmonary complications and hence the goal of management in these patients should be minimising the anaesthetic and operative risk.

Various treatment modalities have been adopted for the treatment of chronic subdural hematomas, namely – burrhole craniostomy with or without drain, twist drill craniostomy, craniotomy and excision of membrane and currently middle meningeal artery embolisation for recurrent hematomas.

Burrhole craniostomy is a simple, safe and effective procedure with results equal to that of craniotomy but with reduced morbidity and mortality and has been most widely advocated in the literature. It has a morbidity of

0.9%. But the procedure of burrhole craniostomy has not been standardized and questions arise regarding the number of burrholes to be used, whether to irrigate or not, whether to keep a drain or not and how to prevent postoperative pneumocephalus and recurrence.

It is usually thought that single burrhole is less efficient to evacuate the hematoma, especially in cases of separated type of chronic subdural hematoma and in thick hematoma. But Yamamoto et al.[29] demonstrated that the irrigation with one burrhole is usually sufficient to wash out the hematoma in multiple cavities. They concluded that in most cases of chronic subdural hematomas, multiplicity did not mean multiple closed cavities and that all hematoma cavities were continuous with relatively wide connections. In their study of 180 patients comparing one vs two burrhole craniostomy, Hong-Joon Han et al.[8] have demonstrated that burrhole craniostomy with one burrhole would be sufficient to evacuate chronic subdural hematoma with lower recurrence rate. In their study he results were analysed in relation to the recurrence rate following single burrhole drainage. The overall postoperative recurrence was 5.6%. The recurrence rate after one burrhole and two burrhole craniostomy was 1.89% and 6.82% respectively. Patients treated with two burrhole craniostomy had a higher recurrence rate than those of one burrhole craniostomy although this was statistically not significant.

The present study was undertaken to compare the efficacy of one burhole vs two burrhole craniostomies in the Indian population. A total of 96 patients were enrolled in the study, out of which 93% were males, 7% were females and most of the patients were above 40 years of age.(Table 2 & 3). 46 patients underwent single burrhole craniostomy while 50 patients underwent double burrhole craniostomy. Factor that were analysed were : postoperative improvements in the Mark Walder Chronic SDH scale and Glasgow Coma Scale, postoperative reduction in thickness of the chronic hematoma, reduction in the midline shift, presence or absence of pneumocephalus and recurrence.

As per Table 1, between group1 and group2, there was no significant difference in the average thickness of the chronic subdural, the residual hematoma, the average midline shift, and reduction in the midline shift postoperatively.

As per Table 2, majority of patients were above 40 years accounting to 88% of the total number of patients in the study.

Both the groups predominantly consisted of male patients accounting for 93% of the total patients as per Table 3.

The most common presenting symptoms of these patients were weakness, altered sensorium and headache. More than half of these patients had the above symptoms. The least common presenting symptom was seizures. 27% of the patients had vomiting. Table 4.

In group1 patients, the mean Mark Walder scale improved from 1.83 preoperatively to 0.76 in the post operative period. The association was statistically significant and resulted in a favourable outcome.(Table 5). In group 2, Mark Walder score improved from 1.80 preoperatively to 0.8 postoperatively. The correlation was statistically significant and had a favourable outcome.(Table 6). The mean Glasgow coma score in both the patients was 15 in the postoperative period showing a statistically significant positive correlation.(Tables 7&8).

Comparing the Mark Walder score between the single and double burrhole groups, no statistically significant difference could be seen(p-value 0.830). The analysis showed that there was no difference between the two groups in the final outcome. It was concluded based on the Mark Walder score that neither of these techniques were superior or inferior if the final outcome alone was taken as the point of contention.(Tables 9&10) .

When the Glasgow Coma Score at the time of discharge was considered, there was no statistically significant difference between the two groups (p-value :0.458). This again emphasizes that both operative techniques resulted in the same outcome.(Table 11&12).

There was no statistically significant difference between the two groups if the reduction in the thickness of the hematoma measured in the preoperative and postoperative CT scans was taken into account(p-value:0.746). It again emphasizes that the two techniques have equal outcome(Table 13&14).

On comparing the reduction of midline shift between the single and double burrhole groups, there was no statistically significant difference between the twoprocedures. p-value:0.237. (Tables 15&16).

On analysing the postoperative CT brain, 1 patient in group 1 had moderate pneumocephalus, whereas 3 patients in group 2 had moderate pneumocephalus. There was no difference between the two groups for the presence of minimal pneumocephalus in the post operative CT. 80% of group1 patients did not have pneumocephalus whereas only 70% of group2 had similar findings. The statistical analysis did not reveal any significant difference between the groups (p-value:0.906) (Tables 17&18).

The overall recurrence rate in the present study was 4.1%, 4.34%(2 out of 46) in single burrhole and 4%(2 out of 50) in double burrhole groups and hence there was statistically no significant difference between the two groups. This compares well with the study of Hong-Joon Han et al. where the overall recurrence rate was 5.6%, even though the recurrence rate of 1.89% in single burrhole and 6.82% in double burrhole was statistically not significant.

Kuroki et al.[12] have compared closed system drainage with irrigation with strict closed system drainage of chronic SDH management. They have suggested that postoperative residual intracapsular air is a factor of recurrence which was statistically significant. But the exact role of postoperative residual subdural air in the recurrence of chronic subdural hematoma is not known. Hoog-Joon Han et al. had hypothesized that patients with one burrhole might have decreased tendency to accumulate postoperative subdural air. Amirjamshidi et al.[2] reported that the persistence of subdural cavity is a risk factor for reaccumulation of the hematoma and the pressure of postoperative residual air prevents reduction of the cavity. Oishi et al.[18] had demonstrated that irrigation should be avoided to prevent complications caused by sudden decrease in intracranial pressure and intraoperative invasion.

The present study attempts at preventing postoperative pneumocephalus and recurrence by using a single burrhole with a closed drain. By this method the subdural space is decompressed slowly; avoiding irrigation of the subdural space and use of a water seal drain prevents the entry of air into the intracranial space. The results with respect to recurrence rate and occurrence of pneumocephalus compares well with the previous studies and proves that single burrhole closed drain technique is equally efficient in the management of chronic subdural hematoma with less morbidity.

CONCLUSION

The study of 96 patients with chronic subdural hematoma comparing single burrhole closed drain technique and double burrhole open drain technique yielded the following results:

1. The improvement in Glasgow Coma Scale and Mark Walder Chronic Subdural Hematoma Scale was the same in both the groups and there was no statistically significant difference between the two groups.

2. The reduction in hematoma thickness and midline shift was also similar between both the groups and statistically insignificant.

3. The recurrence rate was the same (4%) between the two groups and statistically insignificant.

4. The rate of occurrence of pneumocephalus was definitely less with single burrhole technique even though it was statistically insignificant.

5. Since the single burrhole closed system drainage is as efficient as double burrhole irrigation and drainage, with no increased risk of

recurrence and pneumocephalus, the single burrhole closed system drainage may be used routinely in the management of chronic subdural hematoma.

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30. Zollinger R.Gross RE, Traumatic subdural hematoma: an explanation of the late onset of pressure symptoms, JAMA 1934.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
S.No.	Age	Sex	HA	vomit	Seizures	Weakness	LOC	days	Anti	Side	No. of Burrholes	drain	Total	Deficit	Mark	Total	HA	deficit	Mark	Thickness	Residual	reduction	shift pre	shift post	reduction	Pneumo	retap
1	60	m	yes	no	no	no	no	21	no	right	Double	open	15	nil	1	15	nil	nil	0	10	4	6	0	0	0	large	no
2	75	m	no	yes	no	no	no	7	no	right	single	closed	15	nil	1	15	nil	nil	0	11	2	9	2	0	2	nil	no
3	63	m	yes	no	no	yes	no	60	no	left	Double	open	15	right hemiparesis 4/5	2	15	improved	4+	1	20	7	13	10	0	10	nil	no
4	60	m	no	no	no	yes	yes	no	no	left	single	closed	9	left hemiparesis	3	14	nil	improved	2	20	8	10	12	3	9	minimal	no
5	50	m	yes	no	no	no	yes	21	no	right	Double	open	7	nil	3	14	nil	nil	2	13	3	10	12	1	11	nil	no
6	58	m	yes	yes	no	yes	yes	60	no	right	single	closed	14	nil	2	15	nil	nil	0	22	13	9	10	5	5	nil	yes
7	26	m	yes	no	no	no	yes	15	no	right	Double	open	15	nil	1	15	nil	nil	0	12	3	9	6	0	6	nil	no
8	70	m	no	no	no	yes	yes	no	no	left	Double	open	4	decerebrating	4	4		decerebrating	4	22	10	12	10	4	6	nil	no
9	36	m	yes	yes	no	no	yes	65	no	left	single	closed	14	nil	2	15	nil	nil	0	16	4	12	5	2	3	minimal	no
10	54	m	yes	yes	no	yes	yes	60	no	right	Double	open	15	left hemiparesis	2	15	nil	improved	1	12	4	8	15	3	12	minimal	no
11	32	m	yes	yes	no	no	yes	7	no	left	single	closed	15	nil	1	15	improved	nil	1	10	2	8	5	2	3	minimal	no
12	65	m	no	yes	no	yes	yes	no	no	right	Double	open	11	dysphasia	2	15		improved	1	15	7	8	11	4	7	nil	no
13	74	m	yes	yes	no	no	no	45	no	left	single	closed	15	nil	1	15	nil	nil	0	12	4	8	6	2	4	nil	no
14	80	m	no	no	no	yes	yes	30	no	bil	single	closed	8	nil	3	15	nil	nil	0	25	7	18	10	3	7	nil	no
15	64	m	no	no	no	yes	yes	120	no	left	single	closed	6	right hemiparesis 4/5	3	13	nil	improved	2	30	10	20	10	3	7	minimal	yes
16	67	m	no	no	no	yes	no	10	no	left	Double	open	15	right hemiparesis 4/5	2	15	nil	improved	1	25	8	17	5	2	3	minimal	no
17	73	m	no	no	no	yes	yes	14	no	left	single	closed	11	right hemiparesis 4/5	2	15	nil	improved	1	20	5	15	5	2	3	minimal	no
18	60	f	yes	no	no	no	yes	15	no	left	single	closed	15	nil	1	15	nil	nil	0	24	6	18	12	0	12	nil	yes
19	53	m	yes	no	no	no	no	15	no	left	single	closed	15	nil	1	15	nil	nil	0	12	3	9	5	0	5	nil	no
20	45	m	yes	yes	no	yes	yes	50	no	right	Double	open	15	left hemiparesis	2	15	nil	improved	1	15	4	11	4	0	4	nil	no
21	45	m	yes	no	yes	no	yes	14	no	left	Double	open	10	nil	2	13	nil	nil	1	25	15	10	10	10	0	minimal	yes
22	29	m	yes	no	no	no	yes	18	no	left	Double	closed	15	nil	1	15	nil	nil	0	15	3	12	8	0	8	nil	no
23	47	m	yes	no	no	no	no	no	no	right	single	closed	15	nil	1	15	nil	nil	0	18	4	14	9	0	9	nil	no
24	65	m	yes	no	no	no	no	60	no	left	Double	open	15	nil	1	15	nil	nil	0	22	5	17	10	2	8	nil	no
25	67	m	yes	no	no	no	yes	no	no	bil	Double	open	10	confused	2	14	nil	nil	1	16	4	12	0	0	0	nil	no
26	49	m	no	no	no	no	yes		no	right	Double	open	4	decerebrating	4	4	nil	decerebrating	4	30	9	21	20	8	12	nil	no
27	70	m	yes	no	no	yes	yes	7	no	right	single	closed	12	left hemiparesis	2	15	nil	nil	0	24	6	18	14	2	12	nil	no
28	49	m	yes	yes	no	no	no	no	no	right	Double	open	15	restless	1	15	nil	nil	0	19	4	15	11	0	11	nil	no
29	63	m	no	no	no	yes	yes	no	no	right	Double	closed	13	left hemiparesis	2	15	nil	left hemiparesis	1	26	8	18	13	2	11	nil	no
30	68	m	no	no	no	yes	yes	no	no	bil	single	closed	11	right hemiparesis 4/5	2	11	nil	ight hemiparesi	2	18	5	13	12	2	10	nil	no
31	25	m	yes	yes	no	no	no	90	no	right	Double	closed	15	nil	1	15	nil	nil	0	15	3	12	5	0	5	nil	no
32	68	f	yes	no	no	yes	yes	14	no	left	Double	open	15	right hemiparesis 4/5	2	15	nil	improved	1	20	4	16	10	0	10	nil	no
33	43	m	no	no	no	yes	yes	14	no	left	single	closed	13	nil	2	15	nil	nil	0	21	5	16	12	0	12	nil	no
34	67	m	no	yes	no	yes	no	30	no	right	Double	open	15	nil	1	15	nil	nil	0	17	4	13	13	0	13	nil	no
35	76	m	no	no	no	yes	yes	no	no	left	single	closed	9	right hemiparesis	3	13	nil	improved	2	16	4	12	11	0	11	nil	no
36	24	f	yes	yes	no	yes	yes	no	yes	left	Double	open	11	right hemiparesis	2	11	nil	ight hemiparesi	2	25	10	15	10	0	10	minimal	no
37	55	m	yes	yes	no	no	no	30	no	right	double	open	15	nil	1	15	nil	nil	0	20	5	15	10	0	10	nil	no
38	70	m	yes	no	no	yes	yes	no	no	right	double	open	15	left hemiparesis	2	15	nil	nil	0	18	9	9	12	4	8	nil	no
39	75	m	no	no	no	yes	no	no	no	left	Double	open	11	dysphasia	2	11	nil	nil	2	18	4	14	4	2	2	nil	no
40	42	m	no	yes	no	no	no	no	no	left	single	closed	15	nil	1	15	nil	nil	0	13	0	13	10	3	7	nil	no
41	83	m	no	no	no	yes	yes	no	no	right	single	closed	14	nil	1	15	nil	nil	0	16	4	12	11	0	11	nil	no
42	75	f	no	no	no	yes	no	60	no	right	Double	open	15	left hemiparesis	2	15	nil	improved	1	25	6	19	14	0	14	nil	no
43	71	m	no	no	no	yes	no	180	no	left	Double	open	15	right hemiparesis	2	15	nil	nil	0	19	8	11	12	2	10	moderate	no
44	70	m	no	no	no	yes	yes		no	right	single	closed	7	left hemiparesis	3	14	nil	improved	2	16	5	11	12	2	10	moderate	no
45	55	m	no	no	no	yes	yes		no	left	Double	open	11	right hemiparesis	2	14	nil	improved	1	21	8	13	8	3	5	nil	no
46	53	m	yes	yes	no	no	no	60	no	left	Double	open	15	nil	1	15	nil	nil	0	12	5	7	5	3	2	nil	no
47	50	m	yes	no	no	yes	no	no	no	left	Double	open	15	right hemiparesis	2	15	yes	improved	1	18	6	12	11	2	9	nil	no
48	55	m	yes	yes	no	no	no	30	no	left	single	closed	15	nil	1	15	nil	nil	0	15	3	12	6	0	6	nil	no
49	63	m	no	no	no	yes	yes	no	no	left	single	closed	13	right hemiparesis	2	14	nil	improved	2	22	7	15	16	3	13	nil	no
50	67	m	no	no	no	yes	yes	no	no	right	single	closed	13	left hemiparesis	2	13	nil	improved	2	17	6	11	12	0	12	nil	no

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
51	55	m	no	no	yes	no	no	44	no	left	single	closed	15	nil	1	15	nil	nil	0	10	0	10	5	0	5	nil	no
52	41	m	no	no	no	no	yes	7	no	left	Double	open	13	nil	2	15	nil	nil	0	8	3	5	6	0	6	nil	no
53	60	m	no	no	no	yes	yes	90	no	left	Double	open	9	right hemiparesis	3	15	nil	improved	1	12	5	7	10	0	10	minimal	no
54	70	m	no	no	no	yes	yes	6	no	right	Double	open	7	left hemiparesis	3	7	nil	static	3	28	8	20	16	4	12	minimal	no
55	60	m	yes	yes	no	yes	no	7	no	right	single	closed	15	left hemiparesis	2	15	nil	improved	1	18	4	14	11	2	9	nil	no
56	36	m	yes	yes	no	no	no	20	no	right	single	closed	14	nil	2	15	nil	nil	0	12	3	9	5	0	5	nil	no
57	64	m	no	no	no	no	yes	20	no	left	single	closed	15	nil	1	15	nil	nil	0	16	3	13	7	0	7	nil	no
58	60	m	no	no	no	yes	yes	5	no	left	single	closed	14	right hemiparesis	2	15	nil	improved	1	14	3	11	8	0	8	nil	no
59	27	m	yes	no	no	yes	no	40	no	left	Double	open	15	right hemiparesis	2	15	nil	improved	1	12	2	10	5	0	5	nil	no
60	75	m	no	no	no	yes	no	no	no	left	single	closed	15	right hemiparesis	2	15	nil	improved	1	20	5	15	2	0	2	nil	no
61	71	m	no	yes	no	yes	yes	30	yes	right	single	closed	11	left hemiparesis	2	11	nil	improved	2	30	10	20	15	3	12	nil	yes
62	60	m	yes	no	no	no	yes	15	no	left	single	closed	15	nil	1	15	nil	nil	0	12	3	9	3	0	3	nil	no
63	23	m	yes	yes	no	no	no	90	no	left	Double	open	15	nil	1	15	nil	nil	0	20	5	15	12	2	10	nil	no
64	72	m	no	no	no	yes	no	no	no	left	Double	open	15	nil	1	15	nil	nil	0	20	5	15	10	2	8	nil	no
65	70	m	no	no	no	yes	no	no	no	right	Double	open	15	left hemiparesis	2	15	nil	improved	1	17	10	7	6	2	4	nil	no
66	26	m	yes	yes	no	no	no	90	no	left	Double	open	15	nil	1	15	nil	nil	0	13	3	10	5	0	5	nil	no
67	74	m	no	no	no	yes	yes	no	no	left	Double	open	10	right hemiparesis	2	15	nil	improved	1	10	4	6	5	0	5	nil	no
68	70	m	no	no	no	yes	no	30	no	left	single	closed	14	right hemiparesis	2	15	nil	improved	1	20	11	9	12	0	12	nil	no
69	70	m	yes	no	no	yes	yes	60	no	left	Double	open	12	right hemiparesis	2	15	nil	improved	1	17	6	11	10	2	8	nil	no
70	69	m	yes	no	no	no	yes	no	no	bil	Double	closed	14	nil	1	15	nil	nil	0	15	3	12	5	0	5	nil	yes
71	80	m	yes	yes	no	no	no	no	no	left	single	closed	15	nil	1	15	nil	nil	0	21	0	21	2	0	2	minimal	no
72	58	m	yes	no	no	no	yes	14	no	left	single	closed	10	aphasic	2	15	nil	improved	1	10	2	8	4	0	4	minimal	no
73	68	m	yes	yes	no	yes	yes	60	no	right	Double	open	12	left hemiparesis	2	15	nil	improved	1	18	12	5	5	2	3	moderate	no
74	77	m	no	no	no	no	yes	13	no	left	Double	open	15	nil	1	15	nil	nil	0	12	8	4	5	0	5	minimal	no
75	65	m	no	no	no	yes	yes	no	no	left	single	closed	13	right hemiparesis	2	15	nil	nil	0	14	3	11	10	0	10	nil	no
76	70	m	no	no	no	yes	no	14	no	left	single	closed	15	right hemiparesis	2	15	nil	improved	1	20	10	10	13	2	11	minimal	no
77	36	m	yes	no	no	no	yes	no	no	left	Double	open	14	nil	1	15	nil	nil	0	14	3	11	10	0	10	minimal	no
78	45	m	yes	no	no	yes	no	10	no	right	single	closed	15	left hemiparesis	2	15	nil	improved	1	20	8	12	9	0	9	nil	no
79	62	m	yes	no	no	no	no	no	no	right	double	open	15	nil	1	15	nil	nil	0	26	6	20	13	0	13	minimal	no
80	45	m	yes	no	no	no	yes	60	no	left	single	closed	15	nil	1	15	nil	nil	0	20	3	17	10	0	10	nil	no
81	65	m	yes	no	no	no	no	7	no	right	Double	open	15	nil	1	15	nil	nil	0	22	2	20	12	0	12	minimal	no
82	70	m	no	no	no	yes	no	90	no	right	Double	open	15	left hemiparesis	2	15	nil	improved	1	20	12	8	2	0	2	moderate	no
83	57	m	no	no	no	yes	yes	180	no	left	single	closed	13	right hemiparesis	2	15	nil	improved	1	11	5	6	10	0	10	minimal	no
84	54	m	yes	yes	no	yes	yes	no	yes	left	single	closed	13	right hemiparesis	2	15	nil	improved	1	15	5	10	7	1	6	nil	no
85	58	m	no	no	no	yes	no	no	no	left	single	closed	14	right hemiparesis	2	15	nil	nil	1	8	2	6	3	0	3	nil	no
86	78	m	no	no	no	no	yes	no	no	left	single	closed	5	nil	4	7	nil	nil	3	20	4	16	14	2	12	nil	no
87	52	m	yes	no	no	yes	no	no	no	right	single	closed	15	nil	1	15	present	nil	1	14	2	12	9	0	9	nil	no
88	55	m	no	no	no	yes	yes	no	no	right	single	closed	7	right hemiparesis	3	15	nil	improved	1	12	2	10	10	0	10	nil	no
89	47	m	no	no	no	yes	no	10	no	right	Double	open	15	left hemiparesis	2	15	nil	improved	1	13	2	11	5	0	5	nil	no
90	55	f	yes	yes	no	no	yes	16	no	Right	Double	open	15	nil	1	15	nil	nil	0	10	3	7	2	0	2	nil	no
91	72	m	no	no	no	yes	no	no	no	right	single	closed	15	left hemiparesis	2	15	nil	improved	1	29	6	23	5	2	3	minimal	no
92	57	m	no	no	no	yes	yes	14	no	left	Double	open	9	right hemiparesis	3	15	nil	improved	1	21	10	11	10	2	8	minimal	no
93	32	m	yes	yes	no	no	no	no	no	left	single	closed	15	nil	1	15	nil	nil	0	10	2	8	6	0	6	nil	no
94	50	f	yes	no	no	yes	no	no	no	left	Double	open	15	right hemiparesis	2	15	nil	improved	1	14	0	14	10	2	8	minimal	no
95	76	f	yes	no	no	yes	no	90	no	left	single	closed	15	right hemiparesis	2	15	nil	improved	1	22	6	16	2	0	2	nil	no
96	75	m	yes	no	no	yes	no	30	no	right	Double	open	15	left hemiparesis	2	15	nil	improved	1	20	4	16	9	0	9	nil	yes